Gradient-Echo EPI Demonstrates Bilateral Superior Temporal Gyrus Activation During Passive Word Presentation

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PURPOSE:

In this study, time course gradient-echo echo-planar imaging (EPI) was used to examine regional changes in human brain activity involved in the process of human speech perception. Specifically, we examined signal changes from the right and left superior temporal gyri during passive word presentations.

INTRODUCTION:

Recent studies have shown that time course gradient-echo EPI, without the use of contrast agents, produces increases in signal intensity in the contralateral motor cortex during simple finger movements (1) and in the visual cortex during photic stimulation (2). This study examined the sensitivity of EPI to brain activation during a complex cognitive process, i.e. speech perception.

Evidence from human lesion studies suggests that human speech is decoded by perisylvian brain structures of the left, dominant hemisphere (3). In contrast, recent positron emission tomography (PET) studies have shown *bilateral* activation of the superior temporal gyrus during passive word presentation, but not by noise (e.g., 4). The inability of PET to discern lateral hemispheric asymmetries may be due to the relatively low spatial and temporal resolution of this functional imaging technique.

In this study using time course gradient-echo EPI, we predicted that a speech perception task would result in selective activation of the superior temporal gyri, and that this activation would be greater on the left side.

METHOD:

Imaging was performed on a standard clinical GE 1.5 Tesla Signa system using a 30.5 cm i.d. three-axis local gradient coil. A blipped, gradient-echo EPI pulse sequence (TE = 50 ms) was used. Data acquisition time was 40 ms to acquire a 64 x 64 image; FOV was 24 cm. One slice in the coronal plane (20 mm thick section) through the superior temporal gyrus was selected. A series of 128 sequential images were obtained using an interscan delay of 1 s.

Subjects were imaged while listening to a list of words. Each task began with a 28 s baseline period and ended with a 64 s baseline; during the baseline periods, subjects were instructed to remain completely relaxed with their eyes open. After the first baseline period, subjects listened to 12 words read at the rate of one word every 3 s for a total of 36 s.

RESULTS:

Figures 1 and 2 are representative plots of the percent change in signal intensity from a single voxel selected from the left and right superior temporal gyri, respectively, plotted as a function of sequential image number (TR = 1 s). As predicted, selective activation (2.4 percent) of the left superior temporal gyrus was observed during the listening phase. An increase in signal intensity, albeit smaller (1.5 percent), was also observed in the right superior temporal gyrus during listening. The lag between stimulus onset (i.e. first word presentation) and the onset of change in signal intensity change was approximately 4 s.

CONCLUSIONS:

These preliminary findings suggest that a significant 1.5 to 2.4 percent increase in signal intensity can be observed within the superior temporal gyrus during passive word presentations. The percent change in signal intensity was smaller than that observed in our previous studies involving motor activation (4.3 percent). The change in signal intensity was greater in the left superior temporal gyrus than the right, suggesting a hemispheric laterality effect. We are currently repeating this task with a larger number of subjects to establish the reliability of this effect. In addition, the current study did not employ a noise control task to establish that the signal change was a specific response to linguistic processing. To address these issues, we are currently studying a broad range of linguistic tasks with appropriate controls using *multislice* EPI imaging techniques. These studies should establish the usefulness of time course gradient-echo EPI for the study of complex mental operations such as language.

Figure 1

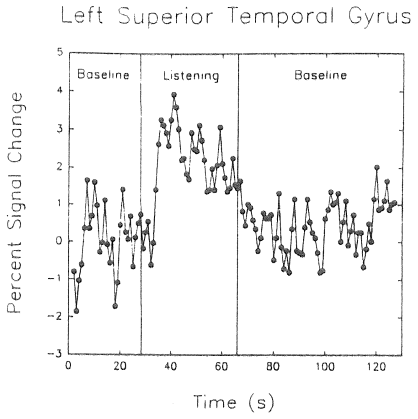
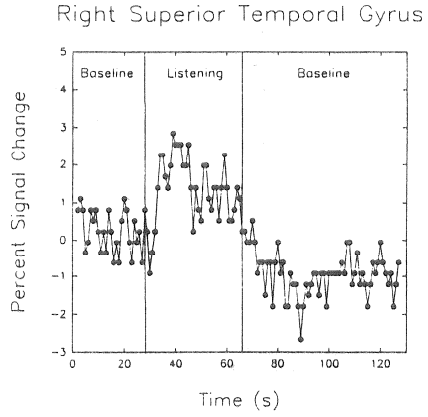


Figure 2



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